

Analysis and Reengineering of the Business Processes at Vacuform Pty. Ltd.

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Submitted in partial fulfilment of the requirements for the degree of

BACHELOR OF INDUSTRIAL AND SYSTEMS ENGINEERING

in the

**FACULTY OF ENGINEERING, BUILT ENVIRONMENT AND INFORMATION
TECHNOLOGY**

UNIVERSITY OF PRETORIA

SOUTH AFRICA

November 2012

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EXECUTIVE SUMMARY

This report is an account of the work done thus far on the analysis and reengineering endeavour at Vacuform.

The literature review details information about other management systems that can be used to solve the problem statement. It also gives the reason why BPR is the best choice for the current situation. The other management systems that are investigated in order to increase the competitive edge of Vacuform are: Downsizing, Material Requirements Planning (MRP), Management Information Systems (MIS), and Continuous Development.

The detailed and comprehensive analysis of the current processes at Vacuform, gives a clear picture of where the problems in the company lie. It also helped decide the processes that would be earmarked for redesign and highlighted areas that could benefit from small improvements. The identified processes are, the manufacturing process and its supporting processes; quality, communication and training.

The identified processes are further analysed and solutions to the problems being experienced were documented in this report

By implementing this project, Vacuform will not only benefit from the increased competitive edge for the business. They will also benefit because their processes will be functioning at the closest level to their highest capacity. The customers will also benefit because their products will be of a better quality and delivery thereof will be accurate. The workers will also benefit as they will start benefiting from the technology and with proper training they will understand how the processes put in place help them.



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CHAPTER 1



1 BACKGROUND AND REVIEW

1.1 Vacuform's Background

Vacuform (Pty) Ltd is a privately owned company that was established in 1974. The company is, situated in Rosslyn Pretoria which is located about 30km from the Pretoria CBD. Vacuform's core business is thermoforming of plastic and poly-urethane (PU) components. The company has recently also added blow moulding to their activities.

At present approximately 80% of the company's turnover is generated from components supplied as original equipment to the South African motor industry. The company owns its own purpose built factory and the size of the property is approximately 5000m². Vacuform also has its own pattern shop to manufacture thermoforming and PU moulds and currently employs ±35 people. Vacuform's major main clientele are currently Ford Motor Corporation (Ford & Mazda), BMW South Africa and Nissan S.A. Figure1 shows some examples of the products that are produced at Vacuform.

Vacuform was a BEE complaint, fully South African company until recently. The company has been bought by an Indian company called Mothersons. Mothersons specializes in injection moulding and opened a company in South Africa, also situated in Rosslyn.

Figure 1: Examples of VacuformProducts.



1.2 Problem Statement

In most instances across South Africa, many small manufacturing businesses, like Vacuform, struggle to meet their customer needs and maintain their position in their various prospective markets. This can be attributed largely to the inefficient and ineffective state of the processes and workflows of the business. The business works on assumptions about its workflows, people, customers and organisational goals that are out-dated and as a consequence are no longer valid. Vacuform is a business experiencing this exact problem.

As it currently stands Vacuform receives pressure from its customers for prompt delivery of quality products at the right time and place. Vacuform tries to get quick solutions to these problems or tries small improvement techniques to isolated problems identified at a specific time. The solution works with the system for a short period of time, after which another problem is identified and the entire solution fails. This leads to the business facing the challenge of unsatisfied customers.

One of Vacuform's biggest customers recently downgraded the company from a first tier supplier (meaning they supply straight to the Original Equipment Manufacturer, also known as an OEM) to a second tier supplier (meaning they supply to another company who then supply to the OEM). This has had the effect that Vacuform has lost the potential profits that could have been gained from any secondary processing (e.g. assembly). These are profits that they could have gained from supplying straight to the OEM. The customer felt that Vacuform's service was unreliable and felt they would rather work with another company.

1.3 Project Aim

The aim of this project is to make a significant contribution to reviving the organisation's competitiveness lost, in part, due to market entrance of competitors as well as the organisation's inability to satisfy customer needs. This will be achieved through identifying, analysing and radically redesigning the company's core business processes.

1.4 Project Scope

For the first part of the project; an in-depth analysis, using business engineering principles and other industrial engineering tools and techniques, will be conducted. This analysis will focus on the current activities of the planning and the monitoring of performance of the business processes at Vacuform. This includes the analysis of current workflows and processes within the organisation to provide a clear insight into the company's business processes. The analysis should provide a clear, unbiased review of the company's business processes and any shortcomings thereof.

Once the aforementioned has been achieved the project will turn its attention to re-thinking and the re-design the organisation's existing resources to realize improvements in cost, quality, service and speed. The project will use industrial engineering tools and techniques and Business Process Engineering (BPR) related strategies (e.g. Total Quality Management (TQM) and Just-in-Time (JIT) to accomplish total reengineering of the processes at Vacuform. All this will be done in the hope of reviving the organisation's competitiveness lost due to market entrance of foreign competitors and the organisation's inability to satisfy customer needs.

1.5 Deliverables

Following are the main deliverables of the project:

- A thorough comprehensive unbiased and well documented analysis of the business processes at Vacuform.
- A strategy to redesign and make improvements on the current business processes.
- A plan on how to improve on identified problems in the business processes.

CHAPTER 2



2 LITERATURE REVIEW

2.1 Introduction

This literature review will not only describe literature on the mentioned topics but will also take the form of a critical discussion showing the insight and awareness of the different theories and approaches to the issues that are discussed.

This literature review will, with the problem statement in mind, seek to increase the company's competitive edge, and provide solutions to the aforementioned problem.

Increasingly companies are beginning to realize that traditional organisational structure, customer service philosophies and business processes are necessary but are no longer sufficient to remain competitive in today's global market. The challenge most companies are face is increasing productivity, providing higher levels of service and responsiveness while keeping costs to a bare minimum.

The sections describe various management techniques that can be used to increase competitiveness.

2.2 Techniques to Improve Competitiveness

2.2.1 Business Process Reengineering

Business Process Reengineering (BPR), also known as business process redesign or business transformation, is a tool designed in the 1900s to address increasing a company's competitiveness in the market place. BPR is often described as the analysis and design of workflows and processes within and between organisations (Davenport and Short, 1990).

Another approach taken to describe BPR is “BPR is basically the fundamental re-thinking and radical re-design of business processes to achieve dramatic improvements in critical contemporary measures of performance, such as cost, quality, service and speed.” (Hammer and Champy, 1993)

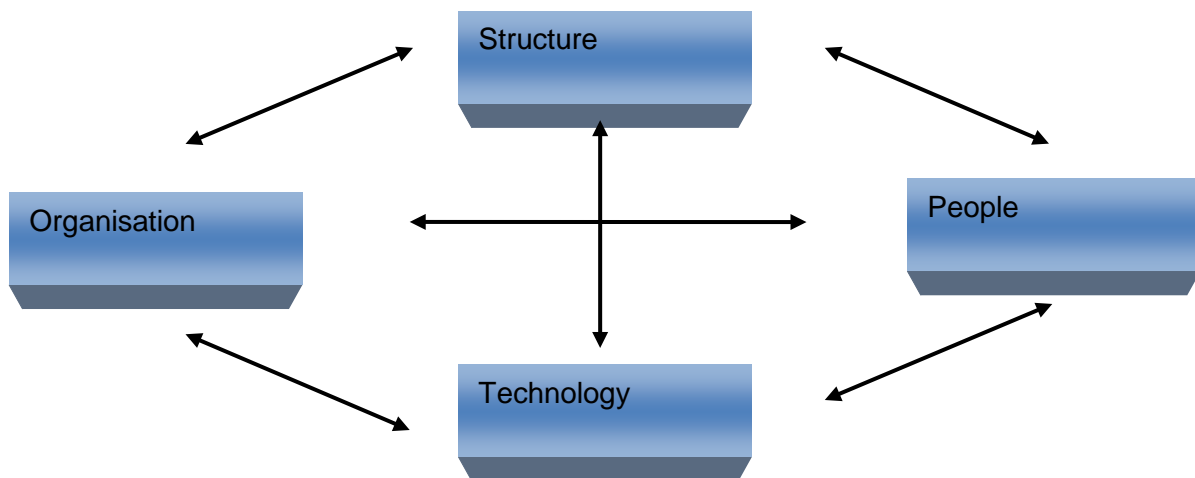
BPR focuses on the core business processes, which directly touch customers, rather than those processes that are completely internal to the company. According to Carr/Johanssen (1995), a business process is a set of linked activities that take an input, transform it and create an output. Some typical core processes in a manufacturing company are:

- Product and Process Design (Time to Market)
- Research and development (Concept to Commercialization)
- Order fulfilment (Order Sign to Delivery/ Install)
- Conversion (Raw Material to Product)
- Procurement (Sourcing to Receipt)
- Logistics (Factory to Customer)
- Material Management Requirement to Consumption)
- Channel Management (Factory to Retailer)
- Supply Chain (Material Source to Customer)

A very useful framework for analysing business and defining change programmes is Leavitt's framework (illustrated in Figure 3). For BPR to be successful, attention must be given to all four domains.

Many managers complain about their BPR efforts failing because they have the wrong of outlook on the process. They do not have enough knowledge on BPR and embark on the BPR effort like it is any other improvement attempt. Most of the dissatisfaction stems from the company undertaking the effort with limited goals, less than full commitment and poorly defined processes. The key to a successful BPR endeavour is for the company to understand exactly what BPR is and how it differs from other improvement efforts. The people (leaders, senior executives and managers) should be 100% behind the effort and they must all do their part to the best of their abilities.

Figure 2: Illustration of Leavitt's framework.



There exists a lot of confusion around what is meant by “radical redesign”. Earl and Khan (1994) describe this as revolutionary rather than evolutionary change (i.e. step rather than incremental change). Some authors have taken a totally different approach and an ideal example is the phenomenon of BPR as “...little more than reworked TQ, continuous improvement, or system led implementation,” (Carr and Johansson; 1995 p.4).

While the first two definitions imply that BPR can provide immense leaps in business performance and totally change the functioning of an organisation, the third definition implies that it is nothing new. This leads to the argument that BPR is merely a fancy term to describe improvement systems that are already being used. Some managers even go as far as labelling BPR efforts as “... good old fashioned cost cutting” (Carr and Johansson; 1995).

2.2.2 Total Quality Management

Total quality management (TQM) is described as an integrative philosophy of management for continuously improving the quality of products and processes (Ahire, 1997). TQM functions on the understanding that the quality of a product is the responsibility of everyone involved in the process of making the product and also those involved in the consumption of said product. TQM involves the workforce, suppliers and even the customers. TQM aims to meet and preferably exceed customer expectation. Cua, McKone, and Schroeder (2001) identified the nine common TQM practices as; (i)cross-functional product design, (ii)process management, (iii)supplier quality management, (iv)customer involvement, (v)information and feedback, (vi)committed leadership, (vii)strategic planning, (viii)cross-functional training, and (ix)employee involvement.

It is usually assumed that TQM and BPR are the same and in yet there are quite different. Wong (1998), states that the difference lies in the basic assumptions of TQM and BPR. TQM assumes that the existing practices or systems are principally right and useful and the target of TQM is to improve on the basis of the existing system. However, BPR assumes the existing system is useless and suggests starting it over. Unlike TQM that aims to achieve smooth and incremental improvements, BPR recommends a complete overhaul that yields dramatic results.

Fahzaneh (2003) identifies another difference between TQM and BPR is in the means each program uses to achieve improvements. That is to say TQM aims at long-term continuous improvements in customer satisfaction and real costs, while BPR offers rapid and radical redesign of strategic processes to optimize the workflow and productivity (Fahzaneh, 2003). Table II highlights some of the main differences between TQM and BPR.

Table I: Fundamental differences between TQM and BPR

Factors	TQM	BPR
Type of Change	Evolutionary- a better way to compete.	Revolutionary- a new way of doing business.
Method	Adds value to existing process.	Challenges process fundamentals and their very existence.
Scope	Encompasses whole organisation.	Focuses on core business processes.
Role of Technology	Traditional support e.g. MIS.	Use as enabler.

2.2.3 Continuous Improvement Process

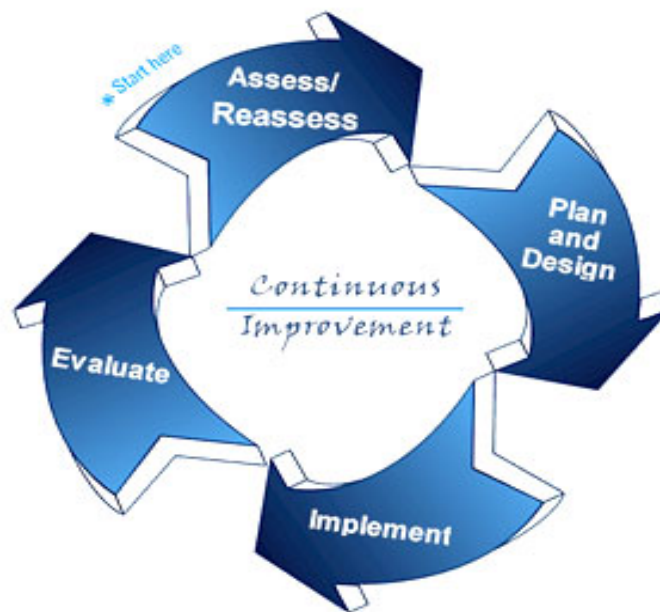
A simple description of Continuous Improvement Process (CIP) is an on-going process to improve products, services or processes (ASQ, 2012). ASQ (2012) goes on to describe CIP as a tool to ensure that delivery (customer valued) processes are continually evaluated and improved in light of their efficiency, effectiveness and flexibility. According to Imai (1986), the core principal of CIP is the (self) reflection of the process (Feedback). Imai (1986) goes on to state the purpose of CIP as the identification, reduction and elimination of sub-optimal processes (Efficiency). The emphasis of CIP is on the incremental, continual steps rather than giant leaps (Imai, 1986).

One of the most widely used tools for continuous improvement is a four-step quality model, the plan-do-check-act (PDCA) cycle. This involves:

1. Plan: Identify an opportunity and plan for change.
2. Do: Implement the change on a small scale.
3. Check (Evaluate): Use data to evaluate the results of the change and determine whether it made a difference.
4. Act (Asses/Reassess): If the change was successful, implement it on a wider scale and continuously assess your results. If the change did not work, begin the cycle again.

Figure 3 is an illustration of the PDCA cycle

Figure 3: The PDCA Cycle



It is also very easy to contrast BPR with continuous improvement. In Table 2, Davenport (1993) gives a useful comparison of CIP and BPR.

Table II: Comparing Continuous Process Improvement (CIP) and Business Process Re-engineering (BPR).

	CIP	BPR
Level of Change	Incremental	Radical
Starting Point	Existing Process	Clean Slate
Frequency of Change	One-time/ Continuous	One-time
Time Required	Short	Long
Participation	Bottom-up	Top-down
Typical Scope	Narrow within functions	Broad Cross functional
Type of Change	Cultural	Information Technology
Primary Enabler	Statistical Control	High
Risk	Moderate	High

2.2.4 Material Resource Planning

Material Resource Planning (MRP) is a production planning and inventory control system used to manage manufacturing processes.

An MRP system is intended to meet three objectives: The first is to ensure materials are available for production and that products are available for customers. The MRP system must maintain the lowest possible material and product levels in store. Lastly it must plan manufacturing activities, delivery schedules and purchasing activities.

2.2.5 Management Information Systems

Management Information Systems (MIS) provides information that is needed to efficiently and effectively (O'Brien, 1999).

Management Information Systems involves three primary resources: people, technology and information or decision making. A successful MIS system supports a business long range plans providing reports based on performance analysis in areas critical to those plans with feedback loops that allow for improvement of every aspect of the enterprise. (O'Brien, 1999)

2.3 Conclusion

From the literature it is clear that the best management process to use for the problem is Business Process Engineering.

The next question often asked is why BPR instead of the many other management concepts that are available. BPR has emerged because it overcomes restrictions usually found in other management systems.

Downsizing involves simply the act of removing people, the methods, work, old systems and methods for getting things done remain the same. This method is only good for the short term and the cracks in the method start to show in the long term because productivity will not increase if people are removed. Thus customer satisfaction and worker moral would be compromised affecting the company's competitiveness negatively.

Technology has been promoted (particularly in the 1980s) as a key to competitiveness. Studies have shown that this is not true and more Management Information Systems (MIS) doesn't mean more productivity or competitive distinction. BPR merely uses technology as an enabler, not a driver.

Functional Performance Improvements initiatives such as Just-in-Time fall short of the type of radical change necessary. They are only one step in the process and they fail to get out of the "box".

Material Resource Planning focuses only on materials and similarly Activity-Based Management focuses solely on reducing costs through Activity-Based Costing (ABC) methodologies. A major downfall of these management approaches is that none of them is strategically focused.

Total Quality Management this strategy has not delivered for many companies because usually, its focus is too narrow and it is limited to improving existing ways of doing business.

Continuous Improvement has been the goal of many companies. This approach although very sound doesn't work if you are not the leader or at least in the level of "best" with the competition. As Paul O Niell, chairman of ALCOA puts it: "Continuous improvement is the right idea if you are a world leader... it is probably a disastrous idea if you are far behind in the world standard... we need rapid quantum leap improvement. We cannot be satisfied to

lay out a plan that will move us towards the existing world standard over some protracted period of time. If we accept such a plan; we will never be the world leader”.

CHAPTER 3

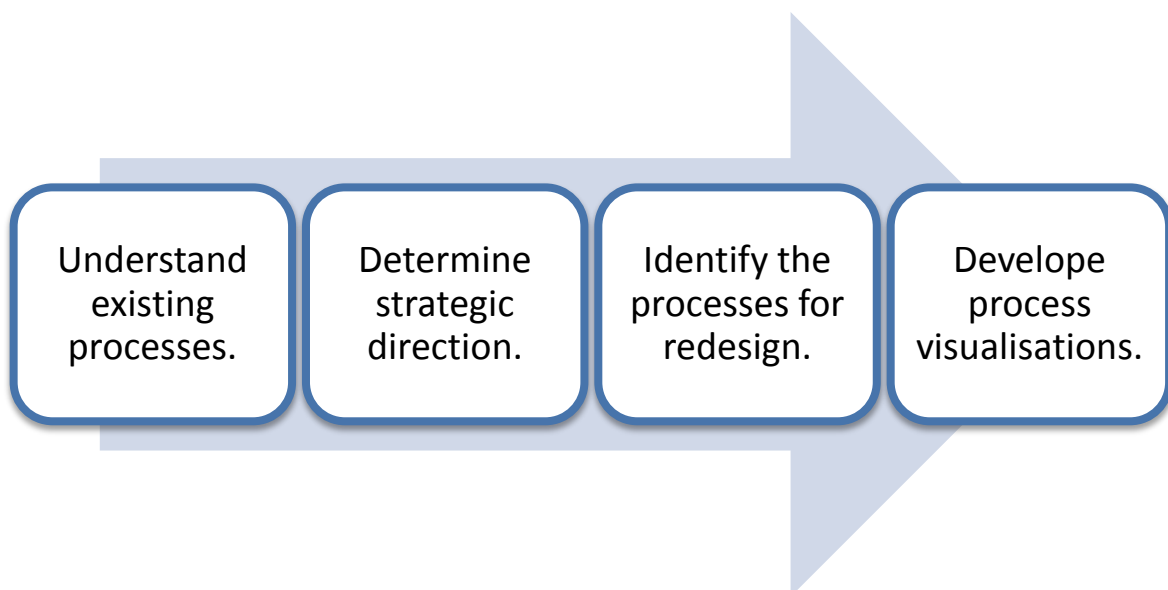


3 RESEARCH

3.1 Research Discovery and Data Collection Design

At this stage of the project, a detailed design of the activities that will be undertaken for implementation of a thorough reengineering process will be done. The required data will be identified, defined and collection thereof will be designed. The data gathered will be analysed and used to draw conclusions. The figure below shows a list of the activities that will be used to achieve this objective. The activities for this stage of the project include: Understanding the existing process, Determine the strategic direction, identifying the processes for redesign and developing process visualizations.

Figure 4: Activities for Research Discovery and Analysis



3.1.1 Understand the Existing Processes

It is very important to understand and document the existing processes. This facilitates communication amongst the reengineering team as the models and documents of the current process allows for common understanding between the team. Documentation provides the means to migrate to a new process. Also, understanding the problems in the current process will ensure that the mistakes are not repeated. Understanding the old process gives a means to measure the value of redesigning. The following are the steps that will be undertaken to understand the existing process.

1. Describe and document current process flow to facilitate communication.
2. Measure process in terms of the objectives and criteria set out for the new process.
3. Determine the process attributes in the existing process that are relevant for the new process.
4. Identify and make known all long standing process problems.
5. Identify short-term improvements in the process.

3.1.2 Determine the Strategic Direction

Determine the company's strategic direction. This is the first step in the reengineering process because the strategic "to be" vision gives the company a consistent course. The company's strategy is derived by asking a series of questions. These questions are, what is the product the company will offer and where will that product or service be offered in terms of segmentation?

The strategy needs to be based on a thorough environmental and competitor analysis. The strategy should prove a comprehensive understanding of the needs and capabilities of customers and suppliers and have an objective analysis of the organisation's resources and capabilities. There should be widespread senior management consensus on the strategic vision. The tools that will be used to determine the strategic direction are:

- MOST Analysis

This is a key tool in investigating corporate strategy and strategic planning. This superior strategic planning tool helps to clarify where the business intends to go (Mission), the key goals which will help to achieve this (Objectives), analysis what options there are for proceeding forward (Strategies) and how these strategies are going to be put into action (Tactics).

- Customer Research

Market research through interviews with customers and potential customers must be done. This provides an external vision of quality and value which is critical to giving the BPR project the capability to produce the right kind of dramatic change.

- Information Management Review

The information review assesses the current and future roles of information technology services (ITS) and the support which they can give the core business processes. This answers the questions:

Can executives see in real time what is happening across the business?

Does the IT system allow processes to run effectively and efficiently?

Are there any ways that processes are constrained by the current IT system?

- Operational Review

The operational review assesses and explains the company's operational effectiveness. It answers the questions:

What can the organisation do and what does it do especially well?

Which processes need enhancement and which can be leveraged?

- Key Performance Indicators (KPIs)

KPIs are used to monitor core processes. The questions which these indicators answer are:

How is the business doing?

How do the executives monitor the business?

How should the executives monitor the business?

- Cultural Assessment Reviews

This reviews the aspects of the organisation's culture that might be resistant to change. The assessment should answer the following questions:

Can the organisation change and how easily can it change?

What are the barriers to change?

What is the level of resistance to change?

3.1.3 Identify the processes for Redesign

The approach used in identifying the core and supporting business processes is one defined by Davenport (1993). This approach consists of a number of activities that must be performed:

3.1.3.1 Enumerate Major Processes

Identify the major processes within the organisation. The best way to do this will be to look at the process critically, ask management what they think the core processes are and list these identified processes. It is best not to list too many or too little processes. Davenport suggests 10-20 processes.

3.1.3.2 Determine Process Boundaries

Scope the process in order to determine its boundaries. The following questions should be asked of the process

- When should the process owner's concern with the process begin and end?
- When should process customer's involvement begin and end?
- Where do sub-processes begin and end?
- Is the process fully embedded within another process?
- Are the performance benefits likely to result from combining the process with other processes or sub-processes?

3.1.3.3 Assess Strategic Relevance

Target the processes to innovate. According to Davenport, there are four criteria to guide process selection.

- The processes centrality to the execution of the enterprise's strategy. For instance, if an enterprise business strategy focuses on improving relationships with customers, the order management process would be a probable choice.
- The processes health, i.e. those processes that are consistently problematic.

- The processes qualification, i.e. where the primary goal is to gauge the cultural and political climate of a target process.
- The processes manageability and scope.

3.1.3.4 Render High Level Judgement on Process Health

Identify those processes that are consistently problematic.

3.1.3.5 Qualify the Culture and Politics of the Process

Measure selected processes' cultural and political climate

3.1.4 Develop Process Visualizations

To achieve a successful BPR implementation initiative, there needs to be a powerful vision of what the future should be like an compelling vision must be clearly defined and effectively communicated as it can be used to guide and motivate the team and enterprise at large (Barrett, 1994).

The process visualisation is closely linked to the business strategy and the business vision. The business strategy and vision sets the context from which the process visualisations will be developed. A business vision is a statement of the businesses values and beliefs, its goals and its overall business philosophy. Business strategy is, essentially understanding an enterprises markets, customers and capabilities, identifying potential market capabilities, identifying potential market opportunities and then allocating resources to take advantage of these market opportunities to improve the financial performance of the enterprise (Barrett, 1994).

The following steps should be undertaken to create effective process visualization:

1. Assess the business strategy for process direction. This will entail examining the strategy to guide and inspire the process visualisations.
2. Consult process customers for process objectives. This entails asking the customers what they want from the process.
3. Formulate process performance objectives. Draw up the actual process objectives in terms of what is to be accomplished.
4. Develop specific process attributes. These are high level process characteristics and specific enablers.

Chapter 4



4 ANALYSIS

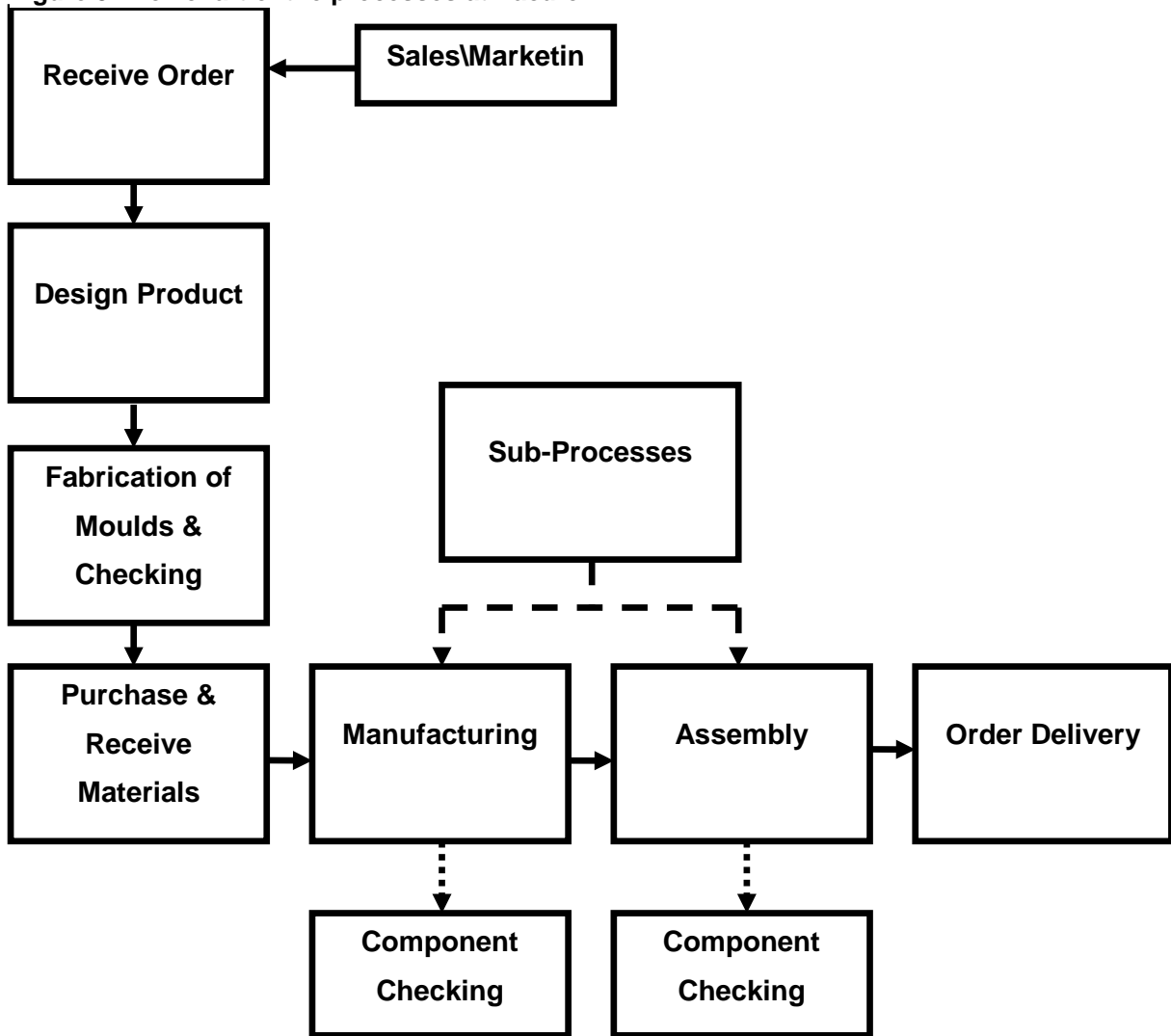
4.1.1 The Current Processes at Vacuform

Vacuform is a small business and does not have a very complex system of core and supporting processes making up its business model. The core and supporting processes at Vacuform include:

- ✓ Core
 - Purchasing
 - Sales, Advertising and Marketing
 - Manufacturing
 - Logistics
- ✓ Supporting
 - Quality
 - Communication
 - Accounting

The following diagram shows the process steps at Vacuform:

Figure 5: Flowchart of the processes at Vacuform



Vacuform currently works on a make-to-order basis. The marketing and sales team rely on the company website and word of mouth to attract potential customers who are usually the motor industry of South Africa.

A potential customer would approach the management team with a particular product that Vacuform will potentially be making for the customer. The customer has to provide specific requirements for the product including measurements, drawings and all critical and non-critical specifications for the part. The customer will usually have a request for an entire line of products as this will make more financial sense.

The line of products is deemed a new project once the contractual negotiations are concluded and a project team is appointed. The resident engineer or the project leader evaluates the product and designs Vacuform specific requirements for the product. The

engineer also draws up a budget for the tooling, material and product costs. This is sent to the sales department who send the customer a quote of the prices involved with making the product.

After the customer has given the go ahead, the project leader sends the designs to the workshop so they can begin making the required tooling. The design specifications and customer requirements are also sent to the quality manager so that they can begin the PPAP process. The designs are also sent to the product development team so that they can develop the production process.

After the tooling has been produced, pre-production begins and all the problems in the production process are identified and removed.

The customer approves the PPAP package when everything is in order and places orders according to the amount of parts the customer needs. The production manager plans the production according to the orders received. The produced parts are inspected for quality assembled if required and delivered to the customer.

4.1.2 Vacuform's Strategic Direction

The MOST Analysis and the SWOT Analysis below reveal that Vacuform has two major issues that are limiting the firm's potential, these are; flaws in the company's processes and Vacuform's unreliability from the customer's perspective. Resolving these flaws could see Vacuform take its place as one of the dominant and competitive first tier supplier to the automotive industry.



Table III: MOST Analysis

MISSION	OBJECTIVES
<ul style="list-style-type: none">• To produce the best quality product that meets the customer's specifications and expectations.• To get the best competitive position in the market and keep it.	<ul style="list-style-type: none">• To keep the current customers the company has.• To attract new customers to the company.• To satisfy the current customer needs.• To function at the highest possible performance level and on par with the capability of the company
<ul style="list-style-type: none">• Ensure the customers get the required product at the right time, in the right form, at the right place.• Satisfy current customers so that they will recommend the company to others. Also increase the marketing effort.• Customer satisfaction should be the most important aspect of the company.	<ul style="list-style-type: none">• Improve on the processes and make sure the process is as efficient and effective as possible.• Understand the exact customer requirements and fulfil them.• The company has to be customer focused.
STRATEGY	TACTICS

Table IV: SWOT Analysis

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> • Vacuform has the expensive infrastructure required to produce the parts required by the • Vacuform has years of experience in thermoforming 	<ul style="list-style-type: none"> • Customers are wary of doing business with Vacuform due to its unreliability. Thus they rather buy from middle companies that buy from Vacuform. • The operations management principals at Vacuform are not at the benchmark standard.
<ul style="list-style-type: none"> • Vacuform can supply straight to the OEM thus adding value to the products themselves and avoiding “middlemen” costs • Vacuform can retain and even expand its customer base if they improve on these processes. 	<ul style="list-style-type: none"> • Vacuform cannot be a first tier company if they don't improve their processes and become more reliable to the customers • Vacuform could keep losing their first tier customers and thus lose a lot of money by opening up the market to middlemen.
OPPORTUNITIES	THREATS

The customer research (typical questions asked in Appendix A) further indicated the customers concerns regarding reliability. Deducing from the answers the customers gave, it is clear that the number one problem that most customers have with Vacuform is the company's unreliability. The Customers expressed concern over number of issues that ranged from receipt of incorrect orders, and of the non-conformance to specification.

This has resulted in the development of a niche market that “middlemen” companies have seen and began to exploit. In essence what these “middlemen” firms and have managed to overcome the challenge of supplying the correct part, at the correct time, at the correct place

and of the best quality. These companies buy products from Vacuform, perform secondary operations on the parts and sell them to the customers thus reducing Vacuform to a second tier supplier. Vacuform is in a good position because it is in possession of the expensive technology required to fabricate the parts but without the secondary value adding processes, the price of the parts is vastly reduced and the ‘middlemen’ companies get a cut of what should have been entirely Vacuform’s revenue and consequently products.

4.1.3 Processes Identified for Reengineering

The processes that have been identified for reengineering are the manufacturing process and its supporting processes which include quality, communication and training of employees

4.1.3.1 Manufacturing

The following are the manufacturing process steps for the thermoforming and blow moulding process

Step 1: As previously mentioned, thermoforming and blow moulding processes are very similar with the exception of the first and forming step. The following will detail how the initial step for the thermoforming and blow moulding processes.

Thermoforming: Large 1m X 2m plastic sheets of High-density polyethylene (HDPE), Acrylonite Butadiene Styren (ABS) or Foam are heated onto a mould at different temperatures according to the type of material used (as illustrated in Table1). They are then cooled for a semi-finished product.

Table V: Thermoforming Temperatures

Material	Thermoforming Temperature
HDPE	390°C-400°C
ABS	390°C-400°C
Foam	290°C-300°C

*Blow Moulding:*The raw materials for this process are virgin HDPE plastic granules and regrind HDPE plastic granules (recycled from waste materials or reject parts). The two are combined with a ratio of 5:3 respectively. The process then uses heat and air pressure to give the parison (molten plastic) the desired shape.

Step 2 Cutting:The cutting process removes large chunks of excess material from the formed part. The excess material can either be reused or sold depending on the nature of the material. HDPE plastic excess material is powdered and reused in blow-moulding as regrind, while the ABS plastic and the foam are sold.

Step 3 Trimming:The semi-finished products are taken to the robotic trimming process. This process produces intricate cuts on the product that would be near impossible to replicate by hand.

Step 4 Deburring and Cleaning:The products have to be deburred and cleaned to get rid of any small imperfections that are still on the product.

Step 5 Inspection:The semi-finished products are inspected to make sure that they conform to customer specifications.

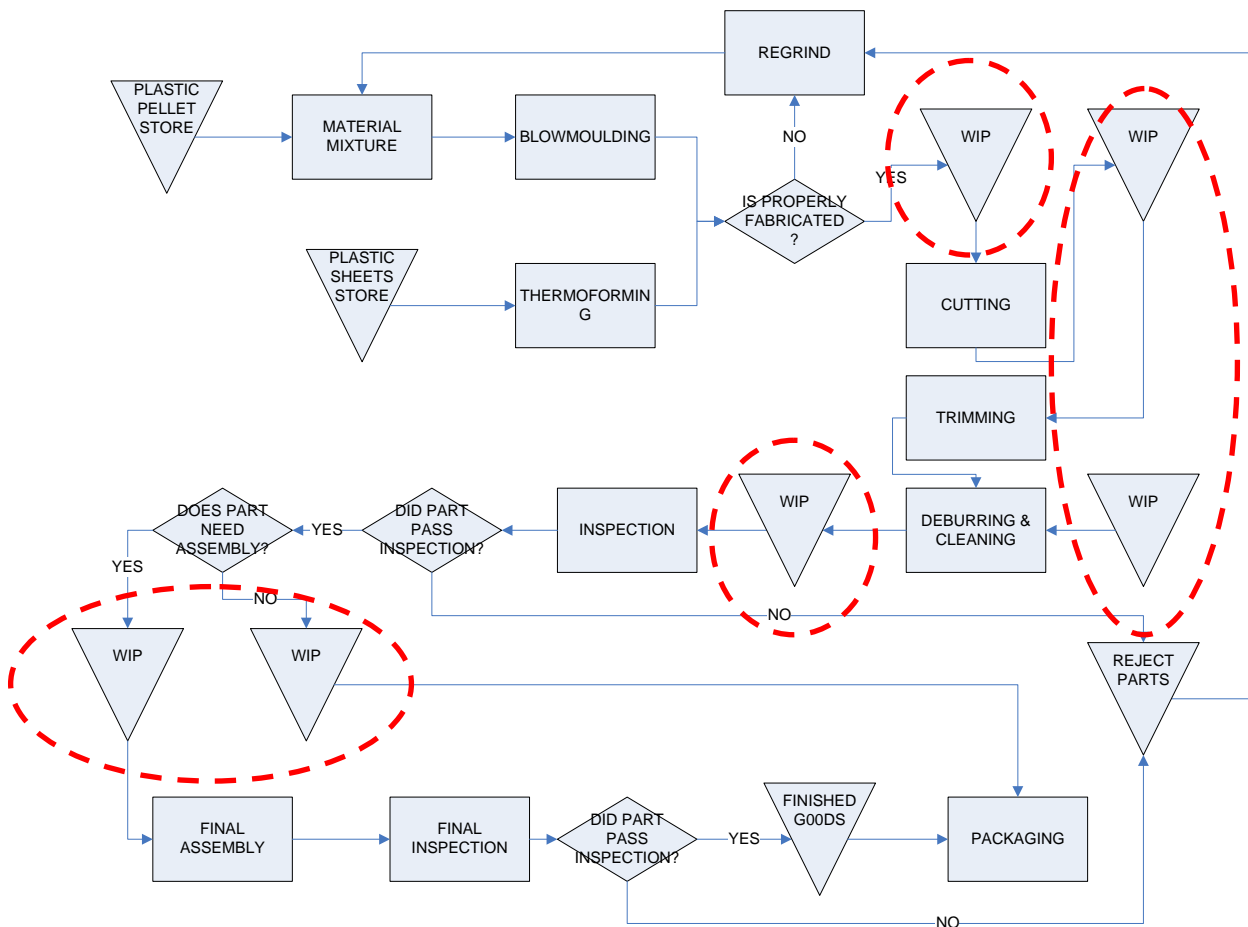
Step 6 Final Assembly:Sometimes the products go through a further assembly process where other products are assembled together with the product to finish it off.

Step 7 Final Inspection:The product then goes through final inspection to make sure that the product is ready for shipment to the customer.

Step 8 Packaging:The parts are packed and labelled.

The following flowchart depicts the activities of the manufacturing process as it currently is:

Figure 6: Manufacturing process flowchart showing WIP.



From the flow chart we can identify that there is too much work-in-progress (WIP). There is WIP after every manufacturing process that takes place. This sometimes creates instances where manufacturing has to stop due to the large amounts of WIP on the manufacturing floor. The largest bottleneck is created at the cutting process because loading and unloading the robot takes very long. An alternative to using the robot is using the manual cutter where an operator has to physically hold and move the part. This helps with the buffer but the cuts are not made as precisely as they are with the robot.

The process was also analysed using statistical process control (SPC) in a previous effort to measure the performance and capability of the process. The results from the SPC showed that the process needs to be totally reengineered as it is not performing as it should be.

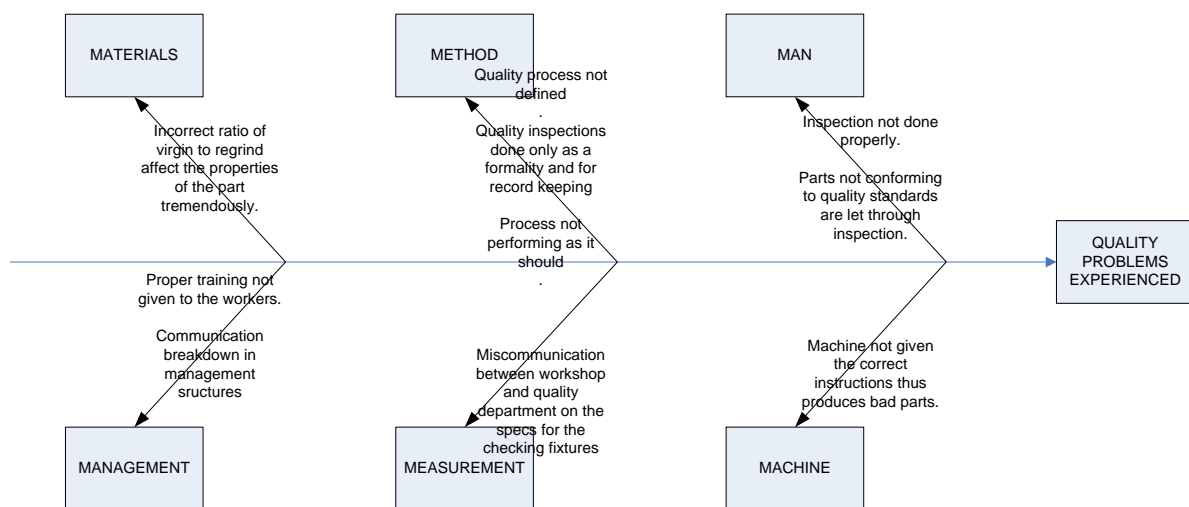
4.1.3.2 Quality

The quality process at Vacuform is currently not very well defined. The quality department doesn't have a predetermined method of quality control that has been put in place. The process relies heavily on damage control instead of doing things right the first time. The

have been countless instances where the products have been sent back from the customer due to a quality discrepancy. It's also not unusual for the customer to have to call in Vacuform staff to the line (in the in car manufacturing capacity) in order to fix products that are not up to the expected standard. This has led to the OEMs rather working with a third party company like Faurecia instead of getting their parts from Vacuform.

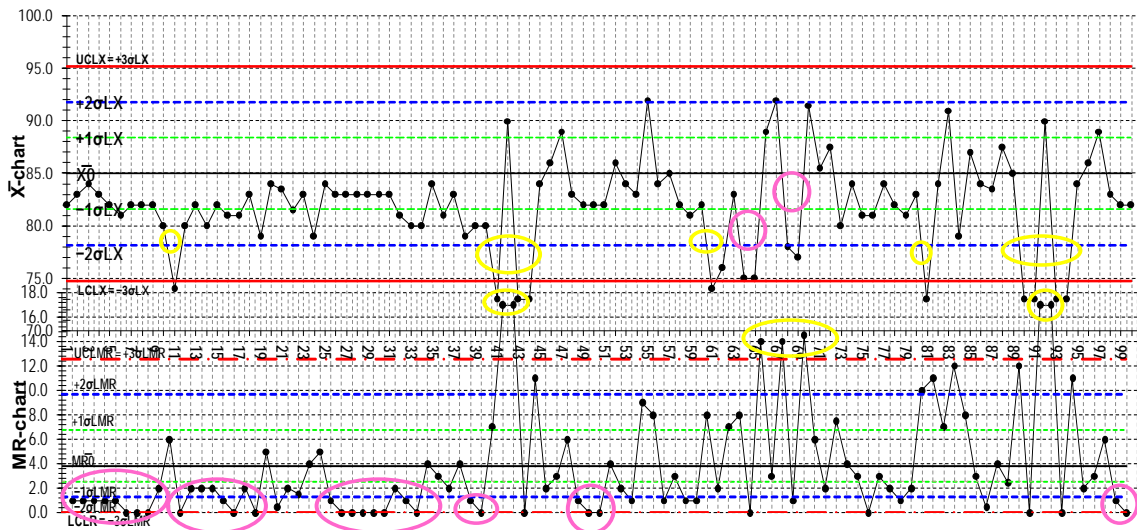
The following ishikawa diagram shows the problems that are leading up to the quality problems that Vacuform is experiencing.

Figure 7: Ishikawa diagram depicting quality problems.



A statistical process control study done on the manufacturing process at Vacuform showed that the process is not performing. It is clear from the control chart below that many of the parts are out of control and that the process is not performing at its highest capacity. A good solution for this problem would be to reengineer the process and find a way to make sure the customers only receive products that fall within the specified spec limits.

Figure 8: Control chart for a manufacturing process at Vacuform



4.1.3.3 Communication

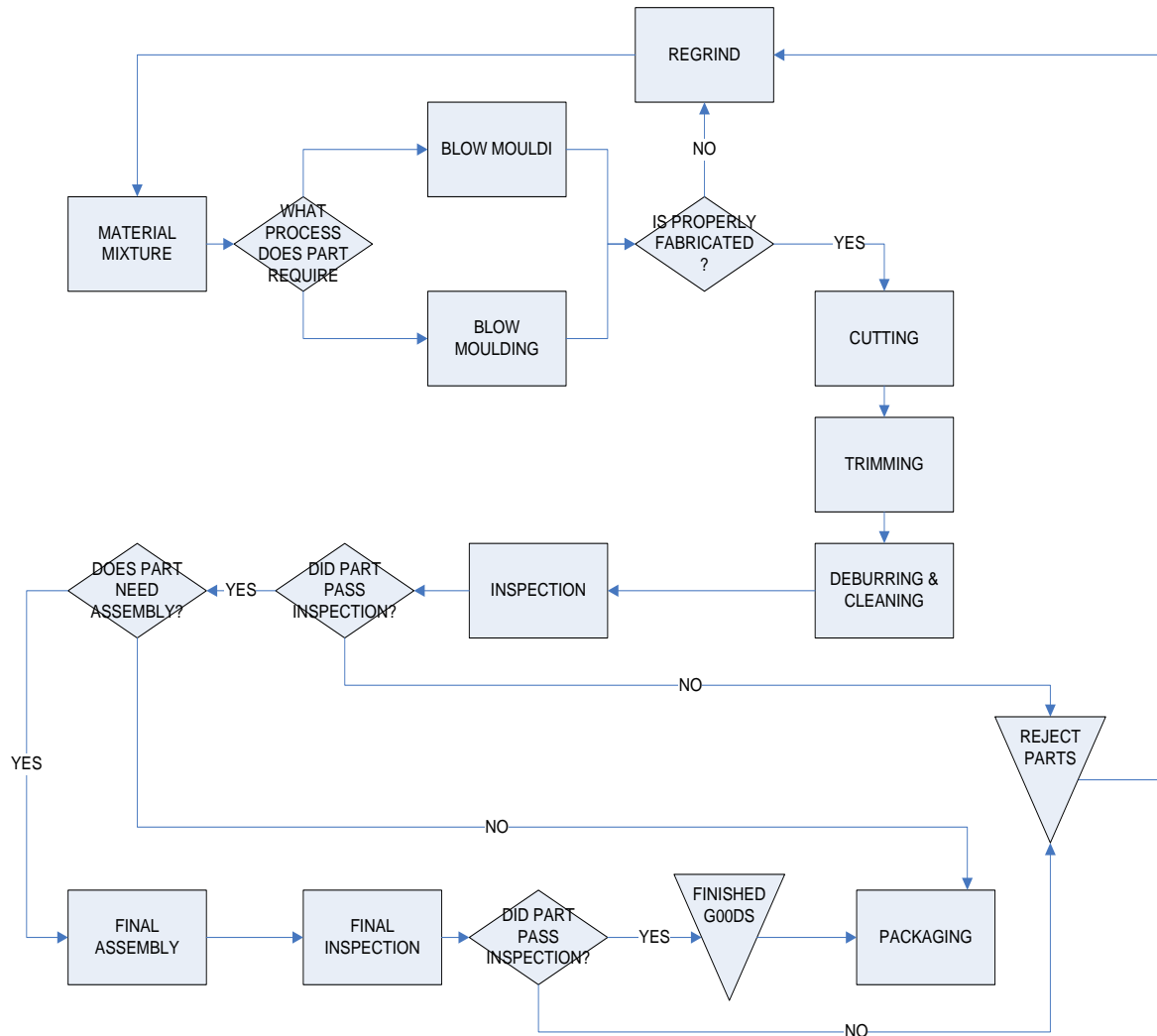
A very big problem at Vacuform is communication. The team at Vacuform relies only on phone conversations and email in order to facilitate communication with each other. This works well in instances where all key players are available and ready to answer questions and send information. This form of communication becomes a problem when someone is not available or when customers ask for certain things. It is important that communication be as simple and convenient as possible.

4.1.4 Process Visualisations

4.1.4.1 Manufacturing

The following diagram shows the ideal manufacturing flow diagram. In this diagram there is no WIP after most any of the processes. Getting rid of the WIP storages will make the process more efficient and effective

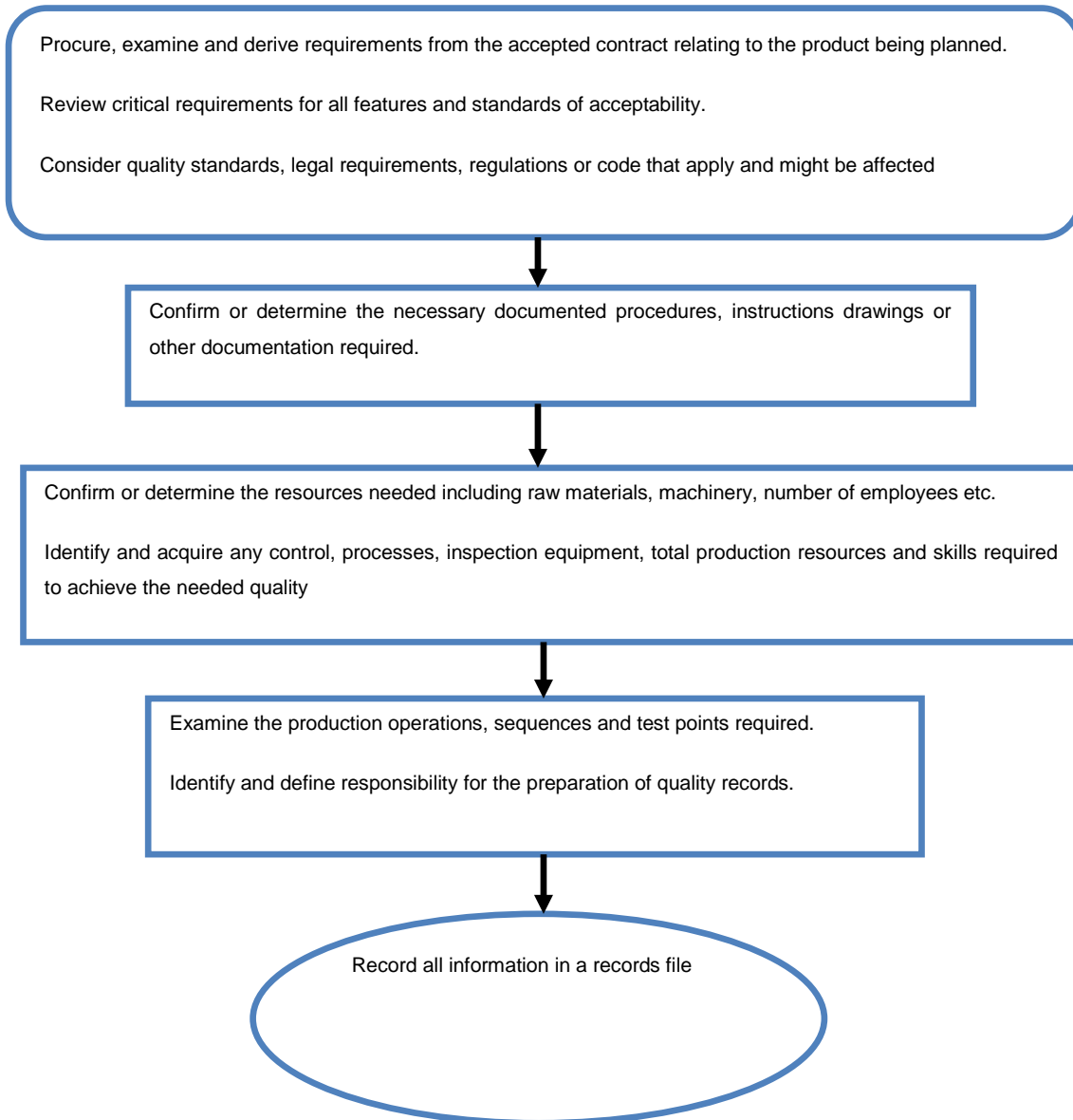
Figure 9: Ideal Manufacturing Flowchart



4.1.4.2 Quality

The ideal quality process is one that would follow the following procedure:

Figure 10: Ideal Quality Process



CHAPTER 5



5 REENGINEERING

5.1 Manufacturing

To achieve the ideal manufacturing process, lean manufacturing with kanban control will be imposed on the manufacturing process in order to improve not only the workflows and waste removals but also improve the quality of the process and parts produced by the process.

A lean manufacturing system is one that meets high throughput or service demands with very little inventory. Kanban control uses the levels of buffer inventories in the system to regulate production. When a buffer reaches its preset maximum level, the upstream machine is told to stop producing that part type. (Bonvik, 1999).

The benefits of applying lean manufacturing include:

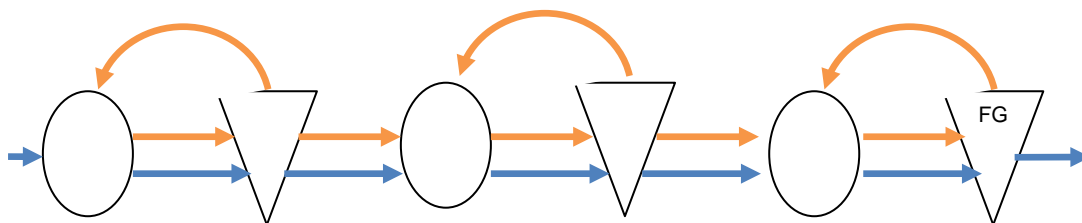
- Reduction of the cycle time
- Reduction of inventory
- Reduction of WIP which will save costs
- An increase in the capacity
- Improved lead times
- An increase in overall productivity
- Improved quality

5.1.1 The kanban system

This is often implemented by circulating cards, known as the kanbans, between a machine and the downstream buffer. Before starting an operation, the machine must have a card. It can then pick raw materials out of its upstream (or input) buffer, perform the operation,

attach the card to the finished part, and then put it in the downstream (or output) buffer. The number of cards circulating determines the buffer size, since once all cards are attached to parts in the buffer. Thus no more parts than the amount of kanban cards in circulation can be made. When the machine picks up raw materials to perform an operation, it also detaches the card that was attached to the material. The card is then circulated back upstream to signal the next upstream machine to do another operation. This way, a demand for a unit of finished goods moves up the supply chain.

Figure 11: Kanban control. Movement of parts shown in blue, circulation of kanban in red. Machines are shown as circles and buffers as triangles. The last buffer is the finished goods (FG) inventory.



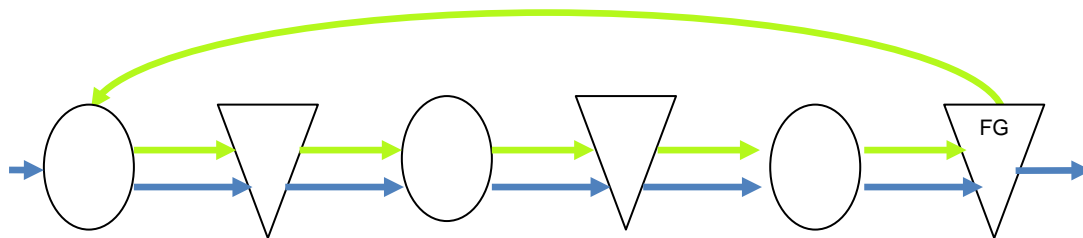
Kanban control ensures that parts are not made except in response to a demand. The analogy is to a supermarket: Only the goods that have been sold are restocked on the shelves. However, it has a major drawback: It uses the parts themselves as carriers of information. A machine is told to stop production when its output buffer is full. This requires that a number of parts sit in the buffer without serving any apparent purpose but to block the upstream machine.

The parts waiting in the buffer act as a buffer inventory. They act to partially decouple the operation of downstream machines from any interruptions of upstream production. If a machine fails, the machine downstream of it can continue production by consuming the parts that are already in the buffer. With luck, the upstream machine will be repaired before the buffer is empty, and the failure will not affect the downstream machine (or the customer on the downstream end of the chain). At the same time the amount of parts in the buffer is controlled and there are no large amounts of WIP on the factory floor that is disrupting the flow of work.

5.1.2 The CONWIP system

CONWIP stands for *Constant Work-In-Process*, and designates a control strategy that limits the total number of parts allowed into the system at the same time. Once the parts are released, they are processed as quickly as possible until they wind up in the last buffer as finished goods. One way to view this is that the system is enveloped in a single kanban cell: Once the consumer removes a part from the finished goods inventory, the first machine in the chain is authorized to load another part. (Bonvik, 1999)

Figure 12: CONWIP control movement of parts shown in blue, circulation of release shown in green



The CONWIP system only responds to actual demands that have occurred, just like the kanban system, so it is still a "pull" type system. But unlike kanban, the resting state of the system has all buffers empty, except finished goods, which is full. This occurs because any part released to the system will move to finished goods. New parts will not be released if the finished goods buffer is full. The inventory in finished goods is now available to serve the customer, and there is no internal inventory or WIP sitting on the factory floor.

The CONWIP control system allows the same throughput and service levels as the kanban but at lower inventories. The advantage will be even greater for a system like that at Vacuform as there are more stages (meaning more internal buffers). The CONWIP system is also easier to implement than the kanban system because there is only one set of cards circulating

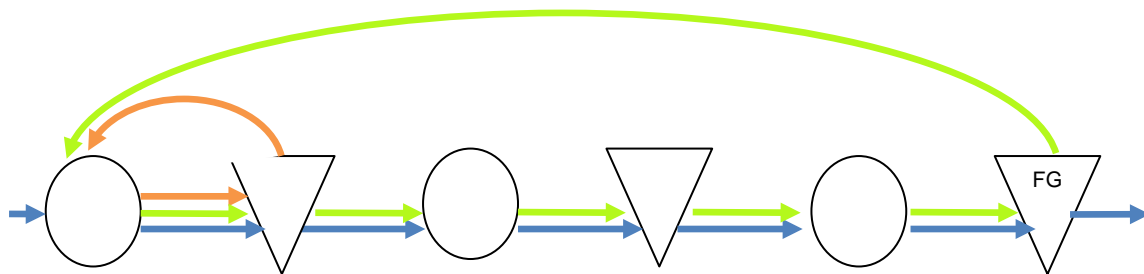
The best recommendation for a company like Vacuform would be a Hybrid Control policy where the CONWIP control policy is supplemented with secondary kanban cells.

This Hybrid control policy works well in a heavily utilized system or where there is a bottleneck in the line. Vacuform has a bottleneck after the cutting process. The buffers towards the upstream end of a CONWIP line will have quite high levels. On the other hand,

kanban control was designed to prevent individual buffer levels from exceeding designated limits.

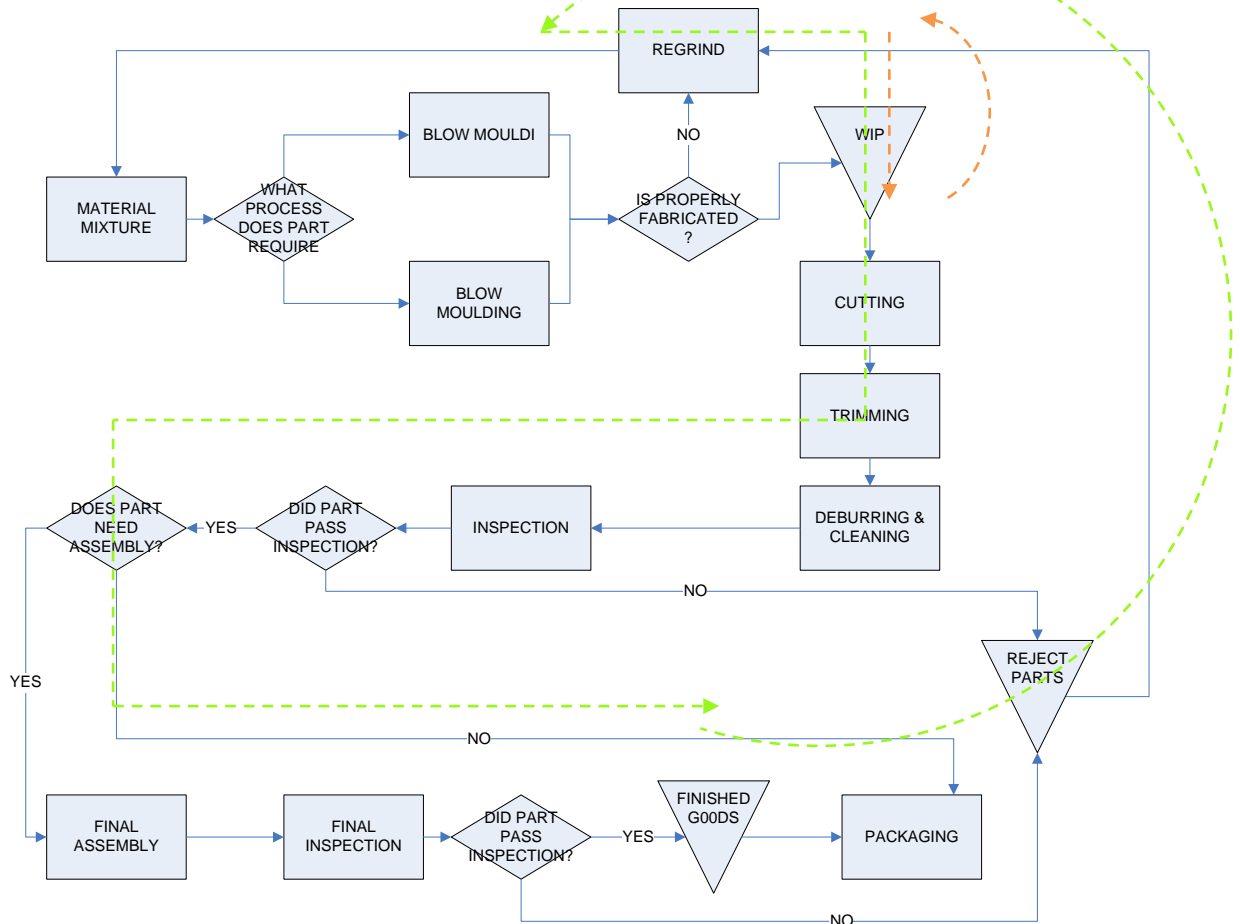
Problems in the line can be detected, and the release of parts to the line if they cannot be processed further can be blocked. We do not need a separate kanban cell to block the last machine, since any material that has gotten this far surely will reach the finished goods buffer if the machine can do an operation. The resulting control policy acts mostly like CONWIP, but at decreased inventories when trouble occurs.

Figure 13:Hybrid CONWIP/kanban control. Movement of parts shown in blue, circulation of kanban in red, and release authorizations in green.



5.1.3 Implementing the Hybrid Control Policy

Figure 14: Flowchart showing Hybrid solution implementation.



The kanban control policy will be used in conjunction with the CONWIP control policy. This will ensure that the best of both policies will be used in order to control the manufacturing process and reduce the large amounts of WIP on the factory floor. The kanban system will be used between the fabrication and cutting process as there is a buffer just before the cutting process. For the rest of the process until the finished goods store, the CONWIP policy will be used.

5.2 Quality

5.2.1 Inspection Policy

The fact that Vacuform is experiencing problems where customers have to return products due to bad quality should be seen as a huge failure of the quality system. The statistical

process control study shows that the process for making the parts at Vacuform is not performing and there are a large number of non-conforming products.

There are three types of inspection policies that Vacuform can use to inspect the parts that they are producing. These policies are:

5.2.1.1 No inspection

This policy sends parts straight into use without screening. This policy would rely on the customers bringing back defective products and the company fixing them. This works well for companies like electric component manufacturers who promise to fix the parts “for free”. The supplier is in fact getting the customer to perform the inspection process for them. This type of policy would only work for a company like Vacuform if the manufacturing process produced 100% perfect parts all the time. Since this is impossible and the company is trying to avoid sending its customers defective parts, this policy would not be best for Vacuform.

5.2.1.2 Sampling inspection

This is also known as acceptance sampling and screens a sample of the parts to determine if the remainder should be accepted or rejected. This type of sampling is less costly than the 100% inspection and is usually recommended in the case where the inspection process is destructive (part is destroyed during inspection). Vacuform is currently using this type of inspection and it seems to not be very effective because there are still instances where more than half the lot of goods sent to customers are defective.

5.2.1.3 100% inspection

This type of inspection screens all the parts and weeds out all the defective parts. From the Statistical process control study, this is the best policy for Vacuform. The downside to this policy is the higher costs and time consumption. The upside is the customer is not supposed to receive any defective part if all the parts are checked.

5.2.2 ISO Certification

To become a 1st tier supplier to the Original Equipment Manufacturers (OEMs), in the automotive industry, there are a number of quality standards that were written by the automotive industry that any would-be supplier must adhere to. These quality and standards were written as a result of strict demand for world class levels of product quality, productivity and competitiveness as well as continual improvement with the hope of improving quality and assuring the integrity of supplies to the auto-industry.

One such industry standard that is subscribed by most automotive Trans National Corporations(TNCs) is the ISO/TS 16949. The ISO/TS16949 is a mandatory requirement to any for any organisation within the automotive supply chain that manufactures and / or adds value to parts for supply to the automotive industry (NQA Services 2012).ISO/TS 16949 is an ISO technical specification which harmonizes and surpasses American and European (specifically German, French and Italian) automotive quality system standards, that includes QS-9000, VDA 6.1, EAQF and ASQ within the global automotive industry (SABS 2012). ISO/TS 16949 specifies the quality system requirements for the design/development, production, installation and servicing of automotive – related products (NQA Services 2012). This specification is only applicable to sites where production or service parts are manufactured, and is in essence a license to trade in the international automotive industry (SABS 2012).Certification is granted by the South African Bureau of Standards (SABS) and it makes use of the auditors that meet the standards of International Automotive Task Force (IATF).

Implementing ISO\TS16949 transforms your operation from detection mode to prevention mode. Prevention is less work and less expense than detection. With an ISO/TS management system, you prevent product nonconformities. Prevent pollution by addressing the causes. Mitigate or eliminate hazards and risks to protect the health and safety of employees and others.

It is also supposed to create consistency throughout the organization built around "best practices" and improves business performance. A well designed, well implemented ISO compliant management system can help improve satisfaction of customers and consumers; and boost internal manufacturing and operational efficiencies.

The ISO/TS16949 management system lessens dependency on key individuals. An ISO management system distributes responsibility and accountability across the work force. More people share more information and accountability for key quality tasks. Result: tasks or processes don't collapse just because one person leaves or changes jobs. And each person carries his or her small share of the load.

The system ensures consistent training. An ISO system is like a collection of road maps. Each road map provides direction from one end of a process to the other. New people to the process are trained using the road map. They refer to the road map while they're learning. Their performance is tested against the road map. And once they know their process, they

don't need to refer to the road map anymore. Except when the process changes, in which case the road map changes and people are retrained to it.

The system also improves management oversight. An effective ISO management system incorporates monitoring and measurement of key performance indicators in quality and customer satisfaction. This gives management objective data upon which to base decisions. The required self-auditing function is even more powerful. Internal auditing is an "early warning system" to help you spot process problems and potential customer satisfaction issues – giving you the chance to address and resolve them before they are detected by others, rather than after. And then management review, closing the loop, provides management with solid data, enabling management to make decisions based on facts

Vacuform currently conforms to the ISO/TS16949. The company has been certified by SABS according to this standard. There are some requirements of the ISO 16949 that Vacuform either no longer conform to and these requirements need to be reinforced in the company. The organisation is required to have documented procedures for the following 6 activities:

- Control of documents
- Control of records
- Internal audit
- Control of non-conforming products
- Corrective action

Vacuform's process for control of documentation and control of records is not performing and has to be reengineered. Training should also be provided to the key individuals who are involved with document control so that the process can be implemented properly.

5.2.3 Other Quality Improvements

In addition to this there is a growing awareness in the auto-industry on the impact vehicle manufacture has on the environment and, although the environmental management certification is a not a requirement to operate, assurance of sustainable environmental management practices has been seen to provide a competitive edge with regards to supplying to TNCs that have want to be good stewards of the environment. The ISO 14000 series is designed to address a number of aspects of environmental management.

The ISO 14000 series specifies practical tools for business concerns that are looking to identify and control their environmental impact and constantly improve their environmental performance. ISO 14001:2004 and ISO 14004:2004 focus on environmental management systems, and ISO 14001:2004 is often seen as the corner stone standard, (and the most well-known) of the ISO 14000 series. In addition to this the ISO 14001:2004 standard is the only one in the 14000 series against which it is currently possible to be certified by an external certification authority, and it is on this basis that the following discussion focuses on it.

In essence what the ISO 14001:2004 does is lay down the criteria for an environmental management system and can be certified to (ISO, 2012). This is achieved through mapping out a framework that a business concern can follow to set up an effective environmental management system, but does not go as far as stating requirements for environmental performance. The ISO 14001:2004 assures procurers, company management, employees as well as external stakeholders that environmental impact is being measured and improved. According to ISO (2012) the benefits of using ISO 14001:2004 include:

- Reduced cost of waste management;
- Savings in consumption of energy and materials;
- Lower distribution costs and;
- Improved corporate image among regulators, customers and the public

If Vacuform can get certification according to ISO14001 they can create a better image of the company to customers and improve on their quality system.

5.2.4 Communication

The communication problem at Vacuform can be fixed by building a user friendly information system. This system will be used to house all electronic documents that the project team uses during execution of a project. Each part or range of parts manufactured for a single customer for the same car is a project. The system should be placed on a network that is easily accessed by all the key players in the projects from their own computers. The system should be such that the users can access each other's work at all times and they can have easy access to any documents that they might need. The system should promote transparency between the different departments and with management. The system should be such that it focuses on the specific needs of the project team and is more than just a space to put information (e.g. drop box). The system should have a simple user interface

and someone who doesn't know a lot about computers should be able to use it. The users will use this system to store the following:

- New project information.
- Problems experienced by the different departments.
- All documents that are pertaining to any of the processes at Vacuform.
- Quality documents those finished and those still being worked on.
- Company Documents (e.g. certification documents)
- All electronic work currently being done by the user.

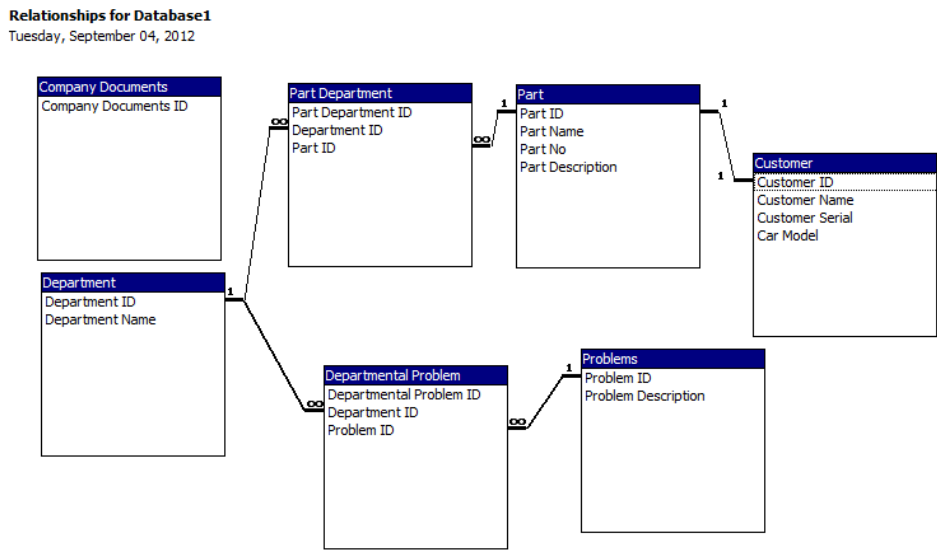
Following is a context data flow diagram. This diagram shows the system and its main interfaces with its environment. The actors in this environment are the people who will be using the information system namely the quality department, the manufacturing department, the management team and the workshop. The context diagram shows what the actors give to the system and what they will be getting out of the system. The interactions from the actors with the system are not set in stone and more interactions and actors may be added to the information system at a later stage.

Figure 15: Context Data Flow Diagram



An entity relationship diagram (ERD) can now be generated from the context data flow diagram. An ERD is a data model that depicts data in terms of the entities and relationships described by that data. The ERD will show how the data will react with each other forming the foundation of the information system. The ERD will be used when doing the actual information system design. The system design will be done in access as everyone at the company already has access on their computers and Microsoft functions are quite basic and easy to learn.

Figure 16: Entity Relationship Diagram



Included with this document is a prototype database that performs the functions that are required by the Vacuform employees. The database can immediately be placed on the LAN server and used by the workers. The user interface is very simple and all the users should be able to understand how to navigate through the information system. A user manual (Appendix D) has been provided to briefly explain how the database works.

5.2.5 Training

5.2.5.1 Training plan

There are many different types of training and all these types of training have to be addressed. The top five training types are:

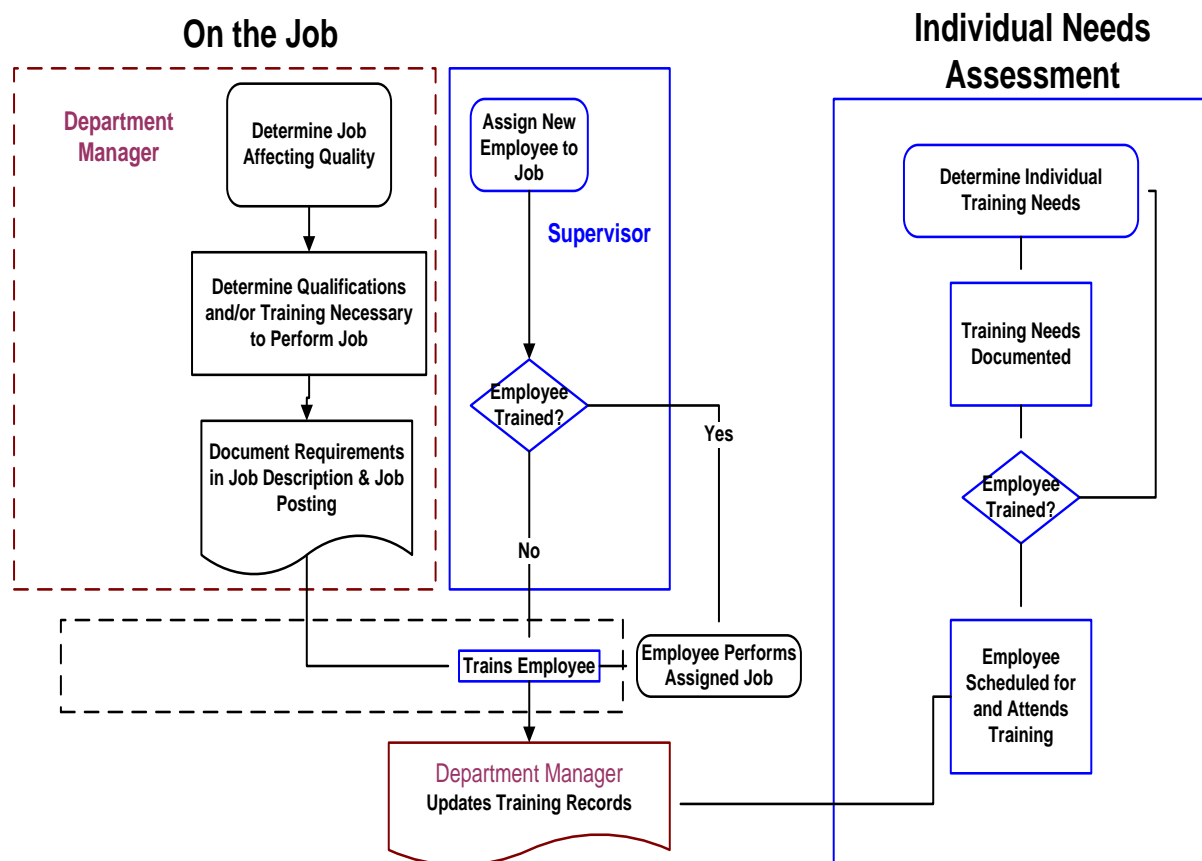
- Orientation, these are the basics that are given when someone begins their employment at a new company.
- On the job, an example of on the job training would be training someone on how to use the cutting robot at Vacuform.
- System/ Procedure Changes, this is the training given whenever a system or a procedure changes. These changes have to be communicated to all key players involved in the change.

- Individual Needs, this is generally training that will help in the future an example would be training someone for a managerial position.
- Elective, where someone chooses to be trained because they are interested in knowing how to do that thing.

It is important that the company addresses all these types of training and they have a plan on how to perform them. It is also important that all training that takes place is recorded because if it is not, it's like the training never happened. Control of training records is very important because they are assessed during registration for certificates and audits.

Following is flow diagrams showing the proposed training plan that can be used by management train the employees.

Figure 17: Training Plan for Vacuform



5.2.5.2 Other Plans

Training or lack thereof is an immense problem at Vacuform. Most of the processes could work just fine if the proper training were given to the workers. This problem is especially

evident in quality because some of the inspections made are visual and the operator has to use his\her judgement. An operator who is not properly trained has a much larger margin for error than one who is properly trained. A suggestion is that Vacuform create an operator training manual that can be used to train the employees on the most basic skills they should have as operators. The manual must have the following characteristics:

- It must be simple, use less words and more pictures
- The operator must have it on his person at all times.
- The operator must want to use it not feel forced to read through it.

The idea is to create a small training manual with something we call “Tip of the Month” on it. These manuals can be given to the workers over a period of three months or more if the idea works. The tips can be laminated and punched with a hole, then placed on a key ring. The workers can then receive these as presents each month and encouraged to read through them during their lunch and when they are home. Appendix F shows an example of slides from such a manual. The booklet will be made in the depicted sizes in order to make it easy to carry around on a key ring. This idea can also be used to make the workers aware of other stuff as well such as housekeeping rules or awareness for certain issues affecting the company.

Chapter 6



6 BUSINESS CASE

Vacuform has recently been downgraded by one of their major customers from a 1st tier supplier to a second tier supplier. This means that Vacuform doesn't supply directly to the customer anymore, they go to another company who performs the finishing operations on the part and then sell the parts to the customers.

The customer has blamed this action on the unreliability of Vacuform to deliver the correct parts in the correct quantity, of the correct quality. They also had a problem with the processes at Vacuform which do not conform to the standard they require for a 1st tier supplier in the manufacturing industry.

The management at Vacuform required a thorough analysis of their processes and identification of the problem areas. They also require an attempt at redesigning of the processes and suggestions for improvements on their processes in order to make their processes become more streamlined and reliable for their customers.

6.1 What are the identified problems and the recommended solutions?

A few problems and solutions were identified and suggested in order to improve the processes and make the company more reliable:

The first problem identified was in the manufacturing process. The factory floor has too much work in progress (WIP) and an effective way to reduce this WIP had to be found. A simulation of the manufacturing process was done in arena to try and identify the cause for this problem. This simulation showed that the robot cutting process and procedure created a bottleneck as there is only one robot and setting up the robot takes a while. The suggested

solution was the implementation of a hybrid kanban/CONWIP system in order to reduce the amount of WIP on the factory floor.

Another problem identified was in the quality products sent to the customers. There were many instances where bad quality products were sent to the customers. The suggested solution for this problem is implementing a 100% inspection policy.

Another problem that has been identified is the problem in communication between the different departments of Vacuform. The solution suggested for this problem is making a simple information system where the different departments can access each other's work. This can be a central storage of all miscellaneous information that is not being handled by the ERP system.

Another problem identified is the lack of a proper training procedure and plan for sustained training for the workers. A training manual was suggested in order to continuously train the workers and provide them with work instructions.

6.2 Implementation and Benefits of the proposed solutions.

6.2.1 Hybrid CONWIP/Kanban Solution

According to Bonvik (1999), similar companies to Vacuform that have implemented this solution have seen a service improvement of more than 40% combined with inventory decreases of about 25%. Vacuform can try this solution on a trial period for 3 months as it is an easy transition from the current process.

Other benefits of the kanban/CONWIP solution include amongst others the following:

- The solution will reduce inventory and product obsolescence. Since component parts are not delivered until just before they are needed, there is a reduced need for storage space. Should a product or component design be upgraded, that upgrade can be included in the final product. There is no inventory of products or components that become obsolete.
- The solution contributes to reducing waste and scrap. With the hybrid kanban/CONWIP solution, products and components are only manufactured when they are needed. This eliminates overproduction. Raw materials are not delivered until they are needed, reducing waste and cutting storage costs.
- Implementing this solution also provides flexibility in production. If there is a sudden drop in demand for a product, the hybrid solution ensures the company is not stuck with excess inventory. This provides the flexibility to swiftly respond to any changes in demand.

- Hybrid kanban/CONWIP also provides flexibility in the way the production lines are used. Production areas are not locked in by their supply chain. They can quickly be switched to different products as demand for various products changes. There are still limits imposed by the types of machines, equipment, and employee skills; however the supply of raw materials and components is eliminated as a bottleneck.
- The solution will help Increase output from the process. The flow of cards will stop if there is a production problem; this makes problems visible quickly, allowing them to be corrected as soon as possible.
- The solution will reduce the waiting time by making supplies more accessible and breaking down administrative barriers. This results in an increase in production using the same resources.

Implementation of this solution can be incorporated when planning production. The system can be introduced for a certain testing period in order to see if the system does in fact decrease the WIP statistics. If the changes do improve the situation then the solution can be used on a wider scale. This solution is risky but if successful could provide a very easy to implement and track solution to the problem being experienced.

6.2.2 100% Inspection Solution

Vacuform currently has 2 operators who perform the checking for all the parts. The operators have extra capacity which can be capitalized on, when implementing 100% inspection. To implement 100% inspection, an additional 2 operators will have to be hired if the parts are still to be delivered on time. The operators receive R30 per hour which works out to R240 per day in an 8 hour working day.

Two extra checking fixtures will have to be manufactured as well. The checking fixture costs around R50000 and normally has a lifespan of 4 years. This means the checking fixture costs an estimated R35 per checking fixture per day. The miscellaneous cost will be the costs incurred for creating the extra workstations. The budget comparing 30% inspection to 100% inspection is as follows:

Table VI: Comparison in cost between 30% inspection and 100% inspection.

	30% Inspection	100% Inspection
Labour Cost per day	R480	R1440
Checking Fixtures per day	R70	R140
Total	R550	R1580
Miscellaneous at 10%	R55	R158
Total per day	R605	R1738

The opportunity costs lost when the wrong quality parts are sent to the customer has to be weighed together with the increase in cost that will be incurred if a 100% inspection policy is adopted. The benefits of 100% inspection are:

- Total 100% customer satisfaction in quality. Theoretically if every single part is checked and the operators are doing their job properly then there shouldn't be anything wrong with the parts
- The time and money wasted when parts have to be bought back to the company due to poor quality can be avoided.
- Customers will have more confidence in the parts they receive from the company.

6.2.3 Information System Solution

The information system needs the following resources in order to be implemented:

- All users must have a personal computer
- An access software package.
- A local area network

The access program can be used effectively because most computers come standard with the Microsoft package and many of the users will be able to use access as it has basic Microsoft functions that are easy to learn if they don't know them already. The information system will be designed such that it doesn't require any extra labour to run it. It will be for the users and run by the users. The users will be able to make changes and add on functions as they require them.

The database will need a LAN so that all users can work on the same database and all changes made can be made on one version of the database. Installing the LAN also makes user management and security easier to manage because you only need to set up user accounts for each user once on a central computer that will be designated as a domain controller rather than having to set up access for each user on each PC. The LAN will connect will connect the user computers and printers together and allow all the users in the network to share resources. The LAN will cost between R200 and R300 per PC depending on the number of PCs in the network and how far apart they are from each other. Each device that will be connected will require a Network Interface Card (NIC) and a wireless switch that connects all the devices.

Table VII: Cost of a LAN

Item	Price
------	-------

Network Interface Cards x8	R2000
Wireless switch	R10000
Total	R12000
Miscellaneous at 10%	R1200
Total	R13200

The benefits of creating a system such as this include the following

- Efficient and effective flow of information in the company.
- “Loss” of important documents will be minimized.
- Time spent looking for documents can be used productively.
- Information not scattered, only one area will house the information.
- Users access each other’s work when faced with problems they can’t handle.
- Management can keep track of what everybody is busy with at all times.
- Create transparency which will impress customers too.

Implementing this information system will be a high benefit low investment scenario. The company has very little to lose if the system turns out to be unsuccessful but a lot to gain if the system is a success.

6.2.4 Training Solution

To implement the training manual solution, the following resources will be required:

- Printer
- Paper
- Laminating Machine
- Laminating Paper
- Paper Cutter
- Key Rings
- Punch
- Labour

The company already has all the required resources that will be needed in order to make the manuals. The only cost incurred will be for the key rings. For the labour required to make the manuals, the company can use students or high school pupils looking for weekend or holiday jobs. This will expose the students to the workings in the company and will provide the company with the cheap labour required to do all miscellaneous jobs around the

company. Two people can be used to make the manual and should require about two days in order to make one set of manuals for the ±30 workers at Vacuform. Following is the expected budget for training:

Table VIII: Training Budget

Item	Cost
Key rings for 500	R1000
Labour	R2000
Total	R3000
Miscellaneous at 10%	R300
Total	R3300

The benefits that can be expected from implementing these manuals include:

- Worker trained on a continuous basis. They have a reference on their person at all times of what to do or not do.
- Workers realize the importance of following instructions and doing their jobs properly. They also can't complain about not knowing the proper procedures.
- When training the worker's, the trainer can use the manuals as a reference.
- Better trained workers which will lead to better processes and products.

Implementation of this solution has huge potential to totally change the way workers few training and the procedure to do their work. It's a practical idea that doesn't require a very big financial investment. The benefits of this have the potential to far surpass the initial investment.

7 CONCLUSION

The analysis has shown that Vacuform actually has really good processes in theory but the implementation of these ideas is hampered by shortcomings highlighted in the supporting processes of the manufacturing process. The fundamental issues like quality, communication and worker training have not been properly addressed. This causes problems in the other processes such as purchasing and logistics.

The biggest problem that is highlighted is the breakdown in communication and flow of information. This seems to be the fundamental problem and the root of all the problems that the company is experiencing. This is a key area for radical redesign. The solution suggested for this problem is an information system that will aid communication by keeping all records and work done in one area and make this information available to all those who might need it

The data gathered also highlights a problem in the quality process of the company. The fact that customers have to return products due to quality issues raises a red flag. This problem can be sorted out by having a proper inspection process that is well documented and communicated to the operators who have to perform these activities. The company is also encouraged to actually implement the ISO standards that they have been certified for because they are there to help the company, they are not just a hurdle you get through then forget.

Training of workers is also a key area for concern. This process is often overlooked and treated as a duty instead of an important part of making sure the all processes are done properly. A plan for on the job and individual needs training was provided to try and combat this problem.

Table 9: The budgeted cost for implementing all the solutions.

Item	Cost
100% Inspection*20 days	R34760
Information system	R13200
Training	R3300
Total	R51260

The total cost amount of implementing these solutions is R51260. Time and people have to also be factored in when making a decision to implement any of these changes. The changes listed will have a relatively minor impact on the way the business is being run at the moment but could go a long way to improving the process flow and customer perception of the business. Vacuform needs to do something very soon because things will not improve by themselves and the solutions listed in this document will provide that push the business needs to start making the required improvements and better the business.

Implementation of the ideas and suggestions made in this report will go a long way in improving the efficiency and effectiveness of the processes at Vacuform. This will improve the company's reliability and its ability to serve its customers. It will also make the business a more attractive option for customers as they will receive better service from the company.

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9 APPENDICES

9.1 Appendix A: Customer Research Questions

Customer Research Questionnaire

1. Name, company employed at and position:

2. Have you ever experienced problems with Vacuform give examples?

3. Are you satisfied with Vacuform as a supplier explain?

4. Would you change suppliers if the opportunity arose?

9.2 Appendix B: Statistical Process Control Calculations

X	82	83	84	83	82	81	82	82	82	80	74	80	82	80	82	81	81	83	79	84	83.5	81.5	83	79	84	2038
MR		1	1	1	1	1	1	0	0	2	6	6	2	2	2	1	0	2	4	5	0.5	2	1.5	4	5	51
X	83	83	83	83	83	83	81	80	80	84	81	83	79	80	80	73	90	73	73	84	86	89	83	82	82	2041
MR	1	0	0	0	0	0	2	1	0	4	3	2	4	1	0	7	17	17	0	11	2	3	6	1	0	82
X	82	86	84	83	92	84	85	82	81	82	74	76	83	75	75	89	92	78	77	91.5	85.5	87.5	80	84	81	2069.5
MR	0	4	2	1	9	8	1	3	1	1	8	2	7	8	0	14	3	14	1	14.5	6	2	7.5	4	3	124
X	81	84	82	81	83	73	84	91	79	87	84	83.5	87.5	85	73	73	90	73	73	84	86	89	83	82	82	2053
MR	0	3	2	1	2	10	11	7	12	8	3	0.5	4	2.5	12	0	17	17	0	11	2	3	6	1	0	135

The type of data collected for the WEIGHT variable is; variable data. This type of data can either be stochastic or deterministic. In this case the data is stochastic. Variable data is linked with the normal distribution and it is assumed that if the data is said to be variable, it follows a normal distribution. The limits for this type of data are valid when the R, s, or MR charts are in control.

For the weight variable, the best chart to use is the individual and moving range (MR) chart. This is appropriate as the data collected is the total yield from one initial production run to make parts for the initial capability study. The sample represents 100 parts all produced consecutively in a single run of the machine. The individual chart will chart the process variability while the MR chart will show the average for the single measurements. Thus $n=1$ for this chart and the sample=100.

Basic Statistics:

$$\sum X = 8201.5$$

$$\sum MR = 381$$

USL=90.2

LSL=79.8

Target Value=82



$$M\bar{R} = \frac{\sum MR}{\text{sample} - 1} = \frac{381}{99} = 3.8485$$

$$M\bar{R}_0 = 3.8485$$

$$UCL_{M\bar{R}} = D_4 M\bar{R} = 3.267 * 3.8485 = 12.57$$

$$LCL_{M\bar{R}} = D_3 M\bar{R} = 0 * 3.8485 = 0$$

$$UWL_{M\bar{R}} = M\bar{R} + \frac{2}{3} (UCL_{M\bar{R}} - M\bar{R}) = 3.8485 + \frac{2}{3} (12.57 - 3.8485) = 9.96$$

$$LWL_{M\bar{R}} = M\bar{R} - \frac{2}{3} (UCL_{M\bar{R}} - M\bar{R}) = 3.8485 - \frac{2}{3} (12.57 - 3.8485) = 1.28$$

$$+1\sigma_{L_{M\bar{R}}} = M\bar{R} + \frac{1}{3} (UCL_{M\bar{R}} - M\bar{R}) = 3.8485 + \frac{1}{3} (12.57 - 3.8485) = 6.67$$

$$-1\sigma_{L_{M\bar{R}}} = M\bar{R} - \frac{1}{3} (UCL_{M\bar{R}} - M\bar{R}) = 3.8485 - \frac{1}{3} (12.57 - 3.8485) = 2.57$$

$$UCL_{\bar{X}} = \bar{X} + A_2 M\bar{R}_0 = 82.015 + 2.66 * (3.8485) = 95.24$$

$$LCL_{\bar{X}} = \bar{X} - A_2 M\bar{R}_0 = 82.015 - 2.66 * (3.8485) = 74.76$$

$$UWL_{\bar{X}} = \bar{X} + \frac{2}{3} (UCL_{\bar{X}} - \bar{X}) = 82.015 + \frac{2}{3} (95.24 - 82.015) = 91.83$$

$$LWL_{\bar{X}} = \bar{X} - \frac{2}{3} (UCL_{\bar{X}} - \bar{X}) = 82.015 - \frac{2}{3} (95.24 - 82.015) = 78.17$$

$$+1\sigma_{L_{\bar{X}}} = \bar{X} + \frac{1}{3} (UCL_{\bar{X}} - \bar{X}) = 82.015 + \frac{1}{3} (95.24 - 82.015) = 88.41$$

$$-1\sigma_{L_{\bar{X}}} = \bar{X} - \frac{1}{3} (UCL_{\bar{X}} - \bar{X}) = 82.015 - \frac{1}{3} (95.24 - 82.015) = 81.59$$

9.3 Appendix C: Training Manual

9/3/

TIP OF THE MONTH

Learning your work

THERE IS AN OBSTRUCTION IN THE CAVITY OF THE PART. A WEB HAS CLOSED OFF THE PART AND AIR CAN'T PASS THROUGH.



THESE MARKS USUALLY INDICATE THE PRESENCE OF A WEB INSIDE THE PART

CLEAN THE PART WELL AND WIPE CLEAN WITH A CLOTH, BEFORE BEGINNING WITH THE FOAM ASSEMBLY




MAKE SURE THERE ARE NO OBSTRUCTIONS INSIDE THE PART USING THE CABLE



THE FOAM SHOULD BE STUCK ON THE PART SECURELY AS TO AVOIDIT COMING OFF AS IN THE PICTURE. THE FOAM PIECE MUST BE NEW AND STILL IN A GOOD CONDITION.

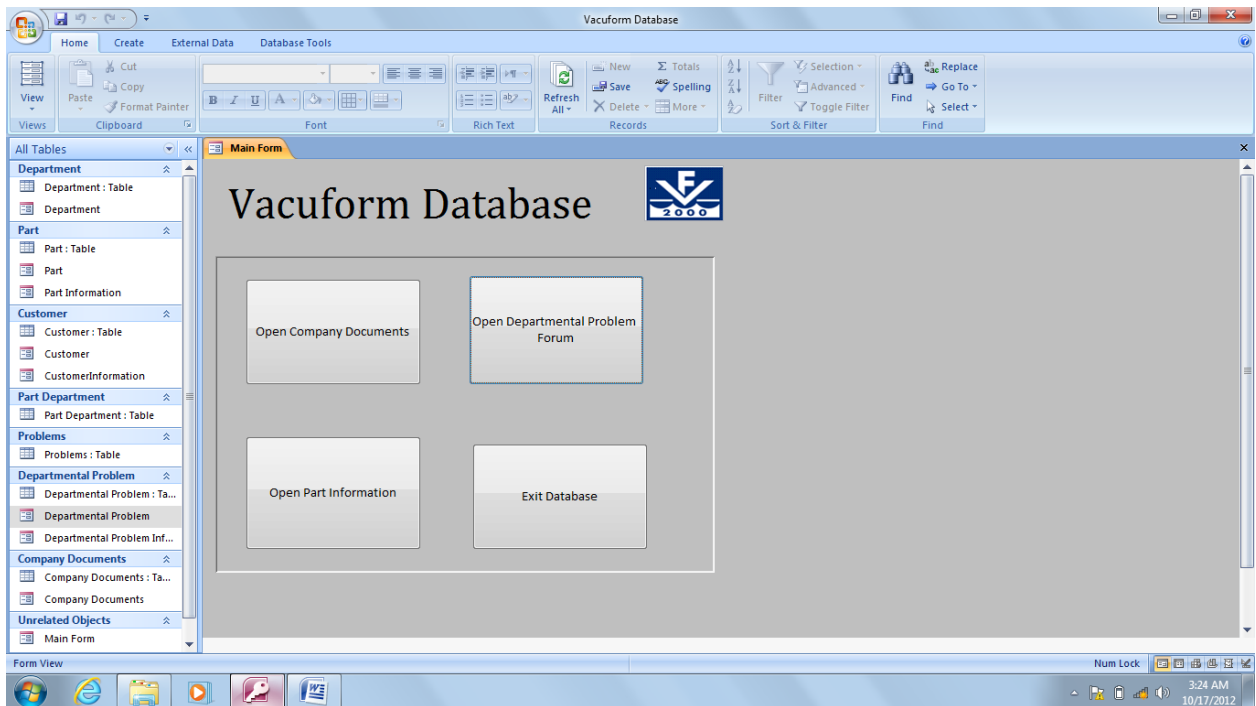


THREADING ON THE PART NOT WELL FORMED.



9.4 Appendix D: Information System User Manual

Information System User Manual



The above picture is the main screen of the information system. It is the page the user will get on opening the information system. The user has a choice between the four items and can click on the desired item button.

Say the user wants to get information on a part. The user will click on the “Open Part Information screen and will be transferred to the following window:

The screenshot shows the 'Vacuform Part' form in the 'Vacuform Database' application. The form is titled 'Vacuform Part' and contains the following fields and values:

Field	Value
Part No	9207331
Part ID	1
Part Name	Rear Vent Duct Frt LH
Part Description	
Part Information	
Customer ID	1
Customer Serial	
Car Model	Ford

At the bottom of the form area, there are two buttons: 'Enter new part information...' and 'Back'. The status bar at the bottom indicates 'Record: 1 of 3' and 'No Filter'.

Here the user can use the part number to locate the part they are looking for and can observe any information they might require about the part. Say for instance the user wants to enter a new part into the system the user can use the “create new part” button on the screen. If a user presses this button, the following screen comes up:

The screenshot shows the 'Part Information' form in the 'Vacuform Database' application. The form is titled 'Part Information' and contains the following fields and values:

Field	Value
Part Description	
Part Information	
Customer ID	(New)
Customer Name	
Customer Serial	
Car Model	

At the bottom of the form area, there are two buttons: 'Back' and 'Save'. The status bar at the bottom indicates 'Record: 1 of 4' and 'No Filter'.

A blank new screen will appear that is ready for the user to make a new record. After recording the part, the user can press the save button which saves the record and provides the same screen so a new record can be entered again. The user may go back from any screen to the screen they were previously using the back buttons on the screen. The other choices on the main window works in a similar way to the sequence explained. To close the database, use the exit button on the main screen.